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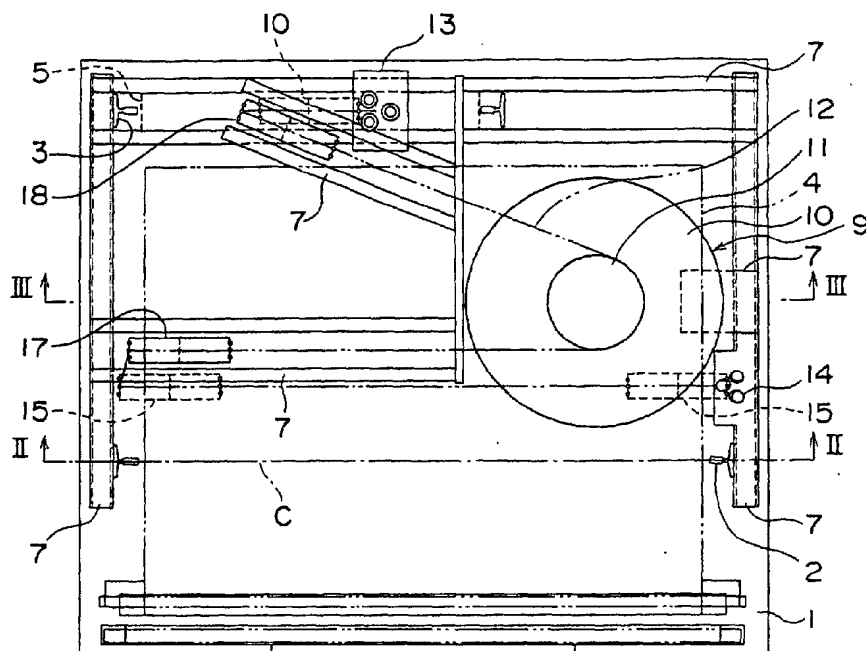
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(54) **ELEVATOR DEVICE**

(57) In an elevator apparatus, a driving machine is disposed horizontally in an upper portion inside a hoistway such that an axis of a drive sheave extends in a vertical direction. A car return sheave for guiding a main rope from the drive sheave to a car and a counterweight

return sheave for guiding the main rope from the drive sheave to a counterweight are disposed in an upper portion inside the hoistway. The car return sheave is disposed such that the main rope extends parallel to a frontage direction of the car between the car return sheave and the drive sheave.

**FIG. 1**



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**Description****TECHNICAL FIELD**

**[0001]** The present invention relates to an elevator apparatus in which a driving machine is disposed in an upper portion inside a hoistway.

**BACKGROUND ART**

**[0002]** A conventional elevator apparatus in which a driving machine is disposed in an upper portion inside a hoistway without disposing a machine room above the hoistway, also known as a "machine-roomless" elevator, is shown in Japanese Patent Laid-Open No. HEI 10-139321, for example. Although the height of a building can be made lower using an elevator apparatus of this kind than in cases where the machine room is disposed above the hoistway separately, with the conventional construction, it is necessary to adjust the positions of return sheaves and a driving sheave on the driving machine in response to changes in elevator car dimensions at the design stage, and installation work has also not been easy.

**DISCLOSURE OF THE INVENTION**

**[0003]** The present invention aims to solve the above problems and an object of the present invention is to provide an elevator apparatus for which installation work is easy, capable of being easily adapted to changes in a frontage dimension of a car while utilizing space inside a hoistway efficiently.

**[0004]** According to one aspect of the present invention, there is provided an elevator apparatus including: a hoistway; a pair of car guide rails and a pair of counterweight guide rails installed inside the hoistway; a car guided by the car guide rails so as to be raised and lowered inside the hoistway; a counterweight guided by the counterweight guide rails so as to be raised and lowered inside the hoistway; a driving machine for raising and lowering the car and the counterweight, the driving machine having a driving machine body disposed in an upper portion inside the hoistway, and a drive sheave rotated by the driving machine body; and a main rope wound around the drive sheave for suspending the car and the counterweight inside the hoistway, the driving machine being disposed such that an axis of the drive sheave extends in a vertical direction, a car return sheave for guiding the main rope from the drive sheave to the car and a counterweight return sheave for guiding the main rope from the drive sheave to the counterweight being disposed in an upper portion inside the hoistway, and the car return sheave being disposed such that the main rope extends parallel to a frontage direction of the car between the car return sheave and the drive sheave.

**BRIEF DESCRIPTION OF THE DRAWINGS****[0005]**

- 5 Figure 1 is a general plan showing an elevator apparatus according to Embodiment 1 of the present invention;  
 Figure 2 is a partial cross section taken along line II - II in Figure 1;  
 10 Figure 3 is a partial cross section taken along line III - III in Figure 1;  
 Figure 4 is a perspective showing a construction of a main rope from Figure 1;  
 15 Figure 5 is a general plan showing an elevator apparatus according to Embodiment 2 of the present invention;  
 Figure 6 is a partial cross section taken along line VI - VI in Figure 5;  
 20 Figure 7 is a general plan showing an elevator apparatus according to Embodiment 3 of the present invention;  
 Figure 8 is a partial cross section taken along line VIII - VIII in Figure 7; and  
 25 Figure 9 is a partial cross section taken along line IX - IX in Figure 7.

**BEST MODE FOR CARRYING OUT THE INVENTION**

- [0006]** Preferred embodiments of the present invention will now be explained with reference to the drawings.

**Embodiment 1**

- 35 **[0007]** Figure 1 is a general plan showing an elevator apparatus according to Embodiment 1 of the present invention, Figure 2 is a partial cross section taken along line II - II in Figure 1, and Figure 3 is a partial cross section taken along line III - III in Figure 1.  
 40 **[0008]** In the figures, a pair of car guide rails 2 and a pair of counterweight guide rails 3 are installed inside a hoistway 1. A car 4 is guided by the car guide rails 2 so as to be raised and lowered inside the hoistway 1. A counterweight 5 is disposed behind the car 4 and is guided by the counterweight guide rails 3 so as to be raised and lowered inside the hoistway 1.  
 45 **[0009]** A mounting frame 6 is secured in a vicinity of upper end portions of the car guide rails 2 and the counterweight guide rails 3. The mounting frame 6 has a plurality of beams 7 and a plurality of rubber vibration isolators 8. A driving machine 9 for raising and lowering the car 4 and the counterweight 5 is mounted on the mounting frame 6. The driving machine 9 has: a driving machine body 10 including a motor and a brake; and a drive sheave 11 turned by the driving machine body 10. The driving machine 9 is disposed horizontally such that an axis of the drive sheave 11 extends in a vertical direction.  
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**[0010]** A plurality of main ropes 12 (only one is shown in the figures) for suspending the car 4 and the counterweight 5 inside the hoistway 1 are wound around the drive sheave 11. First end portions of the main ropes 12 are connected to the mounting frame 6 by means of counterweight rope fasteners 13. Second end portions of the main ropes 12 are connected to the mounting frame 6 by means of car rope fasteners 14.

**[0011]** A pair of car suspension sheaves 15 around which the main ropes 12 are wound are disposed on a lower portion of the car 4. A counterweight suspension sheave 16 around which the main ropes 12 are wound is disposed on an upper portion of the counterweight 5.

**[0012]** A rotatable car return sheave 17 for guiding the main ropes 12 from the drive sheave 11 to the car 4 and a rotatable counterweight return sheave 18 for guiding the main ropes 12 from the drive sheave 11 to the counterweight 5 are mounted to the mounting frame 6. These return sheaves 17 and 18 are disposed such that axes thereof extend in a horizontal direction. Furthermore, the car return sheave 17 is disposed so as to overlap with the car 4 within a vertical plane of projection.

**[0013]** The first end portions of the main ropes 12 are connected to the counterweight rope fasteners 13, the main ropes 12 are wound in sequence around the counterweight suspension sheave 16, the counterweight return sheave 18, the drive sheave 11, the car return sheave 17, and the suspension sheaves 15, and the second end portions of the main ropes 12 are connected to the car rope fasteners 14.

**[0014]** Furthermore, the car return sheave 17 is disposed such that the main ropes 12 extend parallel to a frontage direction of the car 4 (to the left and right in Figure 1) between the car return sheave 17 and the drive sheave 11. In addition, the main ropes 12 are disposed such that portions extending from the drive sheave 11 to the counterweight return sheave 18 are inclined relative to portions extending from the drive sheave 11 to the car return sheave 17. Furthermore, 130 degrees to 180 degrees is a suitable contact angle of the main ropes 12 onto the drive sheave 11.

**[0015]** Furthermore, between the car return sheave 17 and the drive sheave 11, the main ropes 12 are disposed at a distance from and parallel to a center line C joining an interval between the car guide rails 2. 300mm or less is suitable for this distance.

**[0016]** Figure 4 is a perspective showing a construction of a main rope 12 from Figure 1. In the figure, an inner strand layer 24 having a plurality of inner strands 22 and filler strands 23 disposed in gaps between these inner strands 22 is disposed around a core wire 21. Each of the inner strands 22 is composed of a plurality of aramid fibers and an impregnating material such as a polyurethane or the like. The filler strands 23 are composed of a polyamide, for example.

**[0017]** An outer strand layer 26 having a plurality of outer strands 25 is disposed around an outer circumference of the inner strand layer 24. Each of the outer

strands 25 is composed of a plurality of aramid fibers and an impregnating material such as a polyurethane or the like in a similar manner to the inner strands 22.

**[0018]** A friction-reducing coating layer 27 for preventing abrasion of the strands 22 and 25 due to friction among the strands 22 and 25 in the sheaves such as the drive sheave 11, etc., is disposed between the inner strand layer 24 and the outer strand layer 26. A protective coating layer 28 is also disposed on an outer circumferential portion of the outer strand layer 26. A synthetic fiber rope of this kind has a high coefficient of friction compared to a steel rope and is superior in flexibility.

**[0019]** In an elevator apparatus of this kind, since the driving machine 9 is disposed horizontally such that the axis of the drive sheave 11 extends in a vertical direction, and the car return sheave 17 for guiding the main ropes 12 from the drive sheave 11 to the car 4 and the counterweight return sheave 18 for guiding the main ropes 12 from the drive sheave 11 to the counterweight 5 are disposed in the upper portion inside the hoistway, space inside the hoistway 1 is utilized efficiently, enabling height dimensions of the hoistway 1 to be kept small.

**[0020]** Furthermore, because the car return sheave 17 is disposed such that the main ropes 12 extend parallel to the frontage direction of the car 4 (to the left and right in Figure 1) between the car return sheave 17 and the drive sheave 11, changes in frontage dimensions of the car 4 can be adapted to easily. In addition, changes in depth dimensions of the car 4 can also be adapted to easily, simply by adjusting the angle of the counterweight return sheave 18. Consequently, installation work is facilitated, and standardization of equipment is enabled.

**[0021]** In addition, since the main ropes 12 are composed of a synthetic fiber rope having a high coefficient of friction and superior flexibility, diameters of the drive sheave 11 and the return sheaves 17 and 18 can be reduced, enabling installation space for these to be reduced. Consequently, space inside the hoistway 1 is utilized even more efficiently, enabling height dimensions of the hoistway 1 to be kept small.

**[0022]** Furthermore, since the driving machine 9 is disposed horizontally such that the drive sheave 11 is on top, maintenance work on the driving machine body 10 such as on the brake, etc., can be performed easily from on top of the car 4, enabling workability to be improved. Height dimensions required for installing the driving machine 9 and the return sheaves 17 and 18 can also be reduced.

**[0023]** Furthermore, by using the rubber vibration isolators 8 on the mounting frame 6, noise due to vibration of the driving machine 9 and the return sheaves 17 and 18 can be prevented from propagating to a building through the guide rails 2 and 3.

## Embodiment 2

**[0024]** Figure 5 is a general plan showing an elevator apparatus according to Embodiment 2 of the present invention, and Figure 6 is a partial cross section taken along line VI - VI in Figure 5. In the figures, the counterweight 5 is disposed beside the car 4. Accompanying this, the counterweight return sheave 18 is disposed above a side portion of the car 4. Furthermore, the counterweight return sheave 18 is disposed such that an axis thereof extends parallel to an axis of the car return sheave 17. Hence, the main ropes 12 are disposed such that portions extending from the drive sheave 11 to the counterweight return sheave 18 are parallel to portions extending from the drive sheave 11 to the car return sheave 17. The rest of the construction is similar to that of Embodiment 1.

**[0025]** Using an elevator apparatus of this kind, space inside the hoistway 1 is also utilized efficiently, enabling height dimensions of the hoistway 1 to be kept small. Changes in depth dimensions of the car 4 can also be adapted to easily. Consequently, installation work is facilitated, and standardization of equipment is enabled.

## Embodiment 3

**[0026]** Figure 7 is a general plan showing an elevator apparatus according to Embodiment 3 of the present invention, Figure 8 is a partial cross section taken along line VIII - VIII in Figure 7, and Figure 9 is a partial cross section taken along line IX - IX in Figure 7.

**[0027]** In the figures, the counterweight 5 is disposed behind the car 4. A rotatable deflection sheave 31 is disposed in an upper portion inside the hoistway 1. The main ropes 12 are wound around the deflection sheave 31 between the drive sheave 11 and the counterweight return sheave 18. The deflection sheave 31 is disposed such that an axis thereof extends in a vertical direction. The main ropes 12 are disposed such that portions extending from the drive sheave 11 to the deflection sheave 31 are parallel to portions extending from the drive sheave 11 to the car return sheave 17. The rest of the construction is similar to that of Embodiment 1.

**[0028]** Using an elevator apparatus of this kind, space inside the hoistway 1 is also utilized efficiently, enabling height dimensions of the hoistway 1 to be kept small. Changes in depth dimensions of the car 4 can also be adapted to easily, simply by adjusting dimensions of the mounting frame 6. In other words, the layout can be standardized for an elevator apparatus in which the counterweight 5 is disposed behind the car 4, irrespective of the dimensions of the car 4. Consequently, installation work is facilitated, and standardization of equipment is enabled.

**[0029]** In addition, by disposing the deflection sheave 31 between the drive sheave 11 and the counterweight return sheave 18, the contact angle of the main ropes 12 onto the drive sheave 11 can be kept uniform irre-

spective of the dimensions of the car 4.

**[0030]** Moreover, in elevator apparatuses having the layouts shown in Embodiments 1 to 3, it is also possible to use main ropes composed of a steel rope, but space saving is effectively enabled by using main ropes composed of a synthetic fiber rope such as that described above, making the synthetic fiber rope particularly suitable.

## Claims

## 1. An elevator apparatus comprising:

a hoistway;  
a pair of car guide rails and a pair of counterweight guide rails installed inside said hoistway;  
a car guided by said car guide rails so as to be raised and lowered inside said hoistway;  
a counterweight guided by said counterweight guide rails so as to be raised and lowered inside said hoistway;  
a driving machine for raising and lowering said car and said counterweight, said driving machine having a driving machine body disposed in an upper portion inside said hoistway, and a drive sheave rotated by said driving machine body; and  
a main rope wound around said drive sheave for suspending said car and said counterweight inside said hoistway,  
said driving machine being disposed such that an axis of said drive sheave extends in a vertical direction,  
a car return sheave for guiding said main rope from said drive sheave to said car and a counterweight return sheave for guiding said main rope from said drive sheave to said counterweight being disposed in an upper portion inside said hoistway, and  
said car return sheave being disposed such that said main rope extends parallel to a frontage direction of said car between said car return sheave and said drive sheave.

2. The elevator apparatus according to Claim 1 wherein said car return sheave is disposed so as to overlap with said car within a vertical plane of projection.

3. The elevator apparatus according to Claim 1 wherein said driving machine is disposed horizontally such that said drive sheave is on top.

4. The elevator apparatus according to Claim 1 wherein a contact angle of said main rope onto said drive sheave is 130 degrees to 180 degrees.

5. The elevator apparatus according to Claim 1 wherein said main rope between said car return sheave and said drive sheave is disposed at a distance from and parallel to a center line joining an interval between said car guide rails. 5
6. The elevator apparatus according to Claim 1 wherein said main rope between said car return sheave and said drive sheave is disposed at a distance of 300 mm or less from and parallel to a center line joining an interval between said car guide rails. 10
7. The elevator apparatus according to Claim 1 wherein said counterweight is disposed behind said car, said main rope being disposed such that a portion extending from said drive sheave to said counterweight return sheave is inclined relative to a portion extending from said drive sheave to said car return sheave. 15  
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8. The elevator apparatus according to Claim 1 wherein said counterweight is disposed beside said car, said main rope being disposed such that a portion extending from said drive sheave to said counterweight return sheave is parallel to a portion extending from said drive sheave to said car return sheave. 25
9. The elevator apparatus according to Claim 1 further comprising a deflection sheave around which said main rope is wound between said drive sheave and said counterweight return sheave, being disposed in an upper portion inside said hoistway such that an axis extends in a vertical direction. 30
10. The elevator apparatus according to Claim 9 wherein said counterweight is disposed behind said car, said main rope being disposed such that a portion extending from said drive sheave to said deflection sheave is parallel to a portion extending from said drive sheave to said car return sheave. 35  
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11. The elevator apparatus according to Claim 1 wherein said main rope is composed of a synthetic fiber rope. 45

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FIG. 1

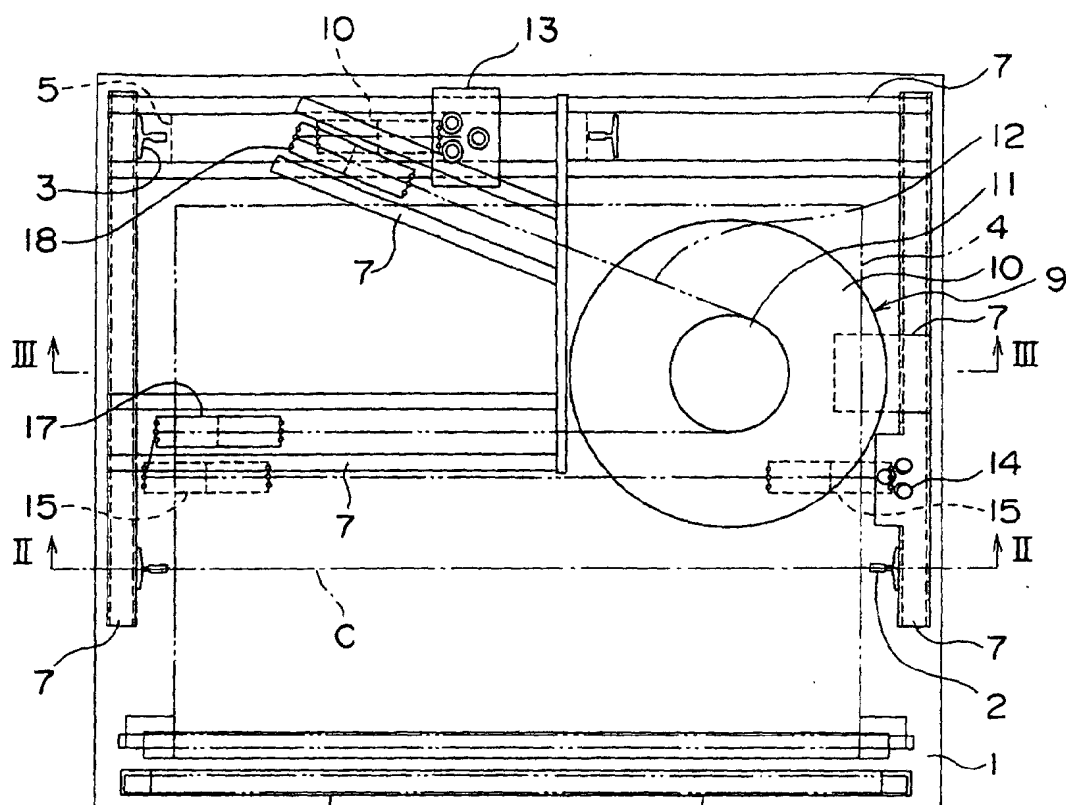


FIG. 2

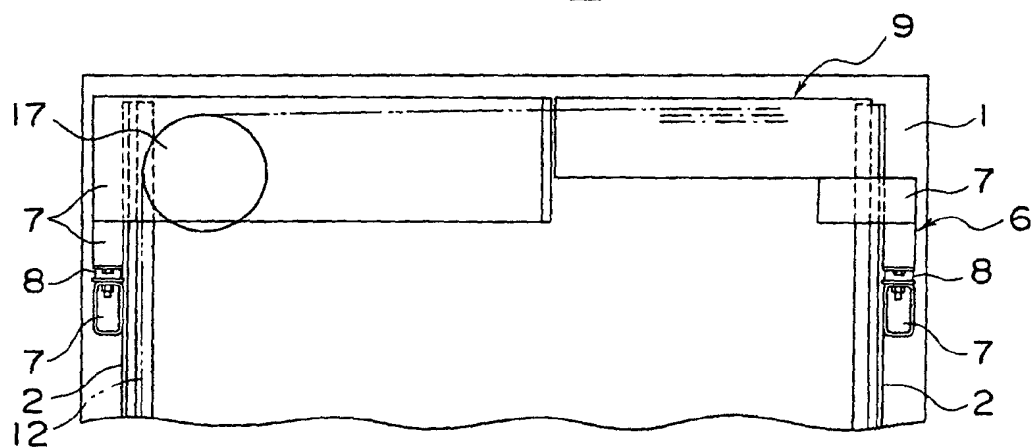


FIG. 3

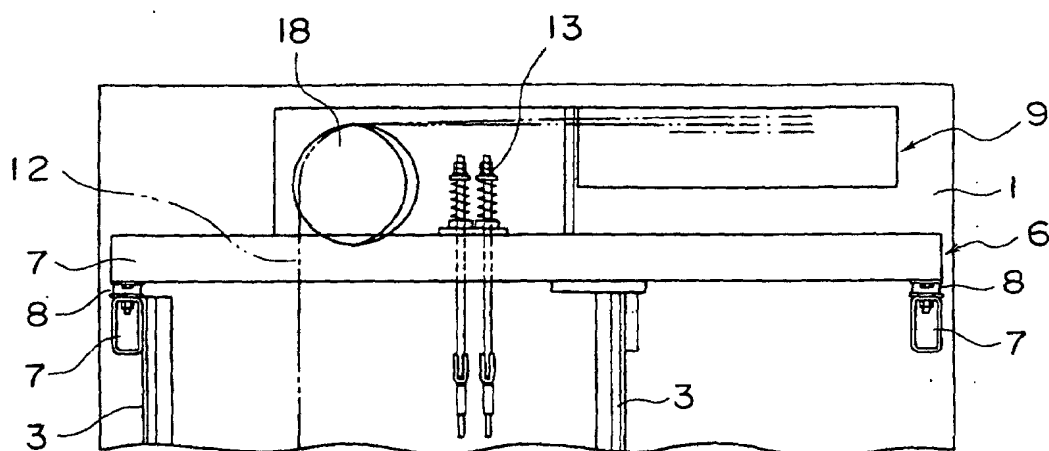


FIG. 4

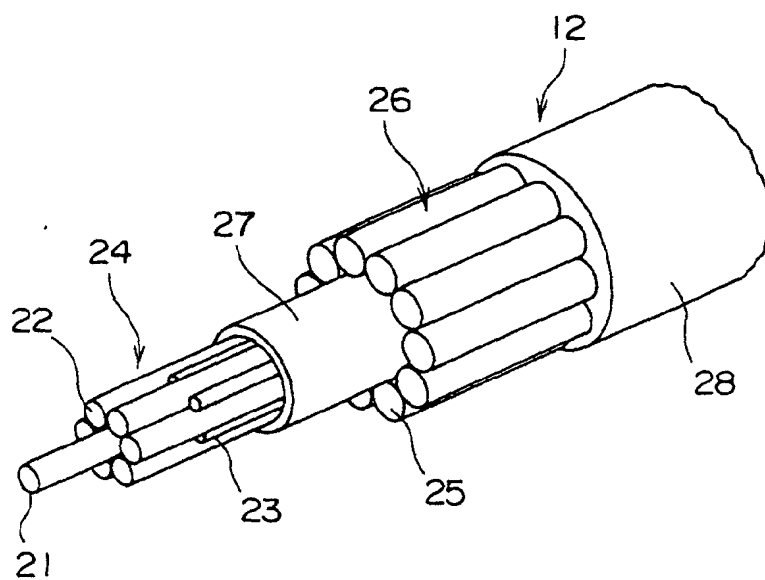


FIG. 5

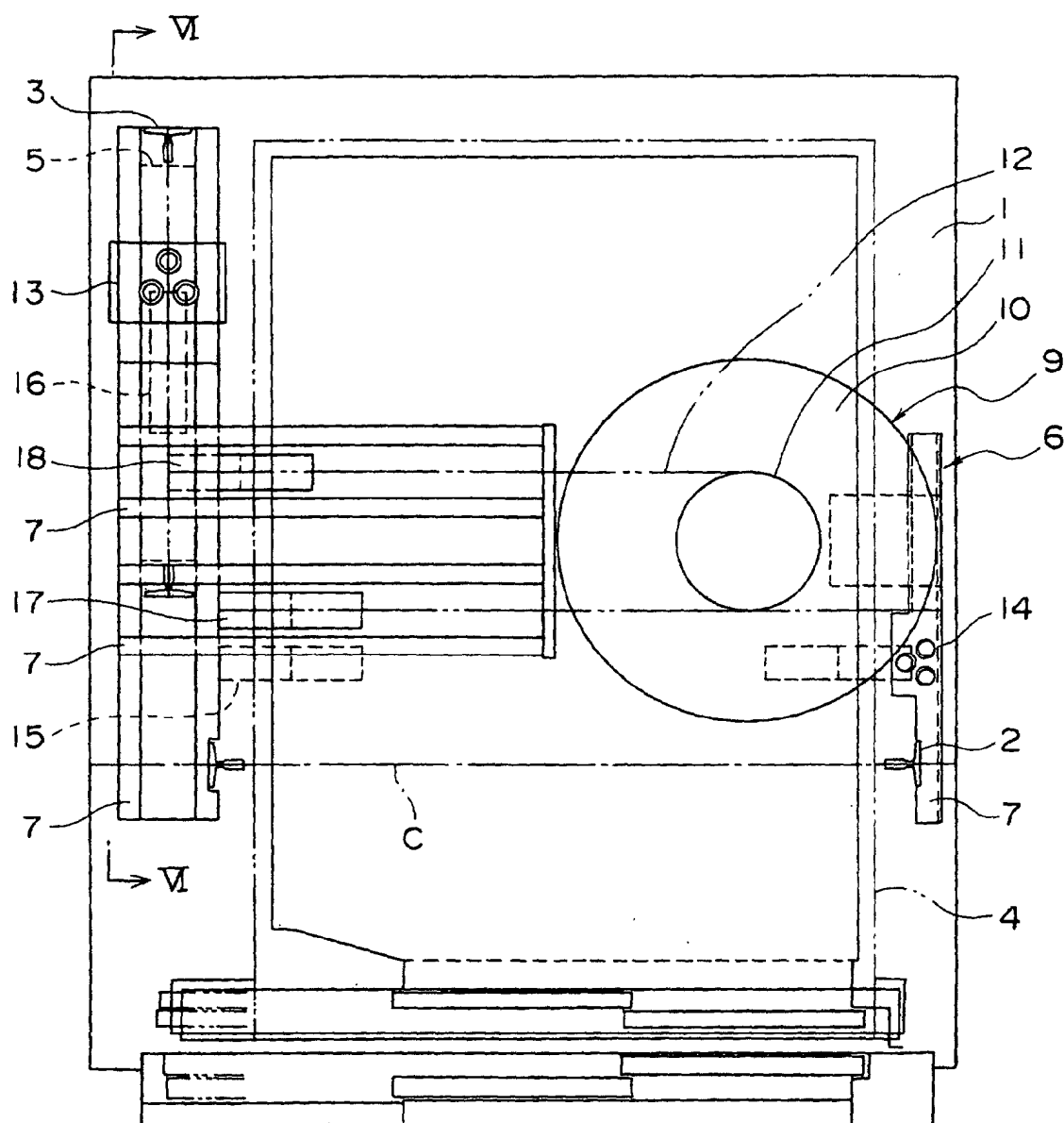


FIG. 6

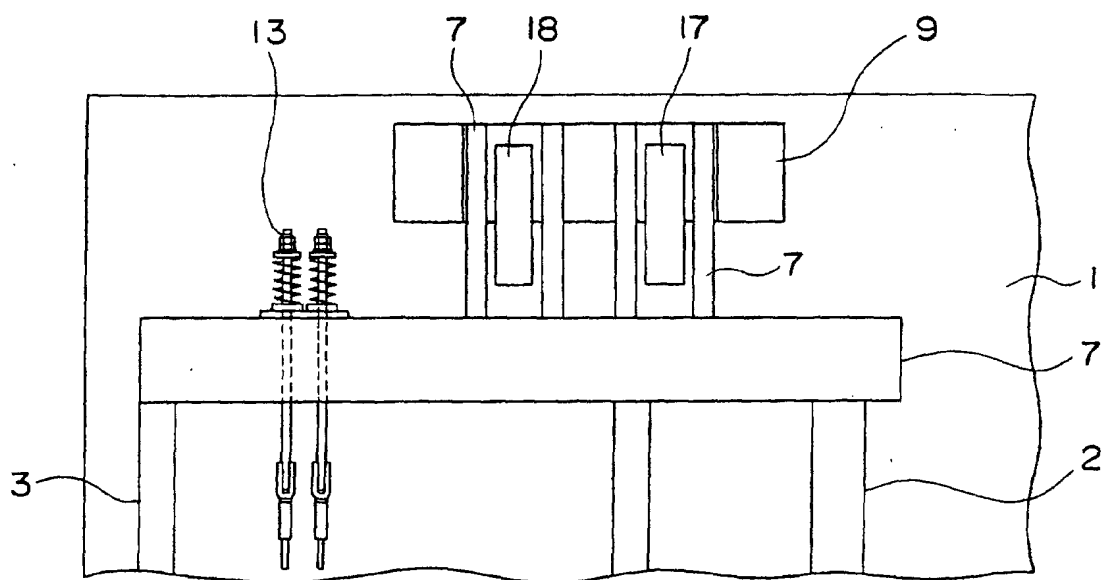


FIG. 7

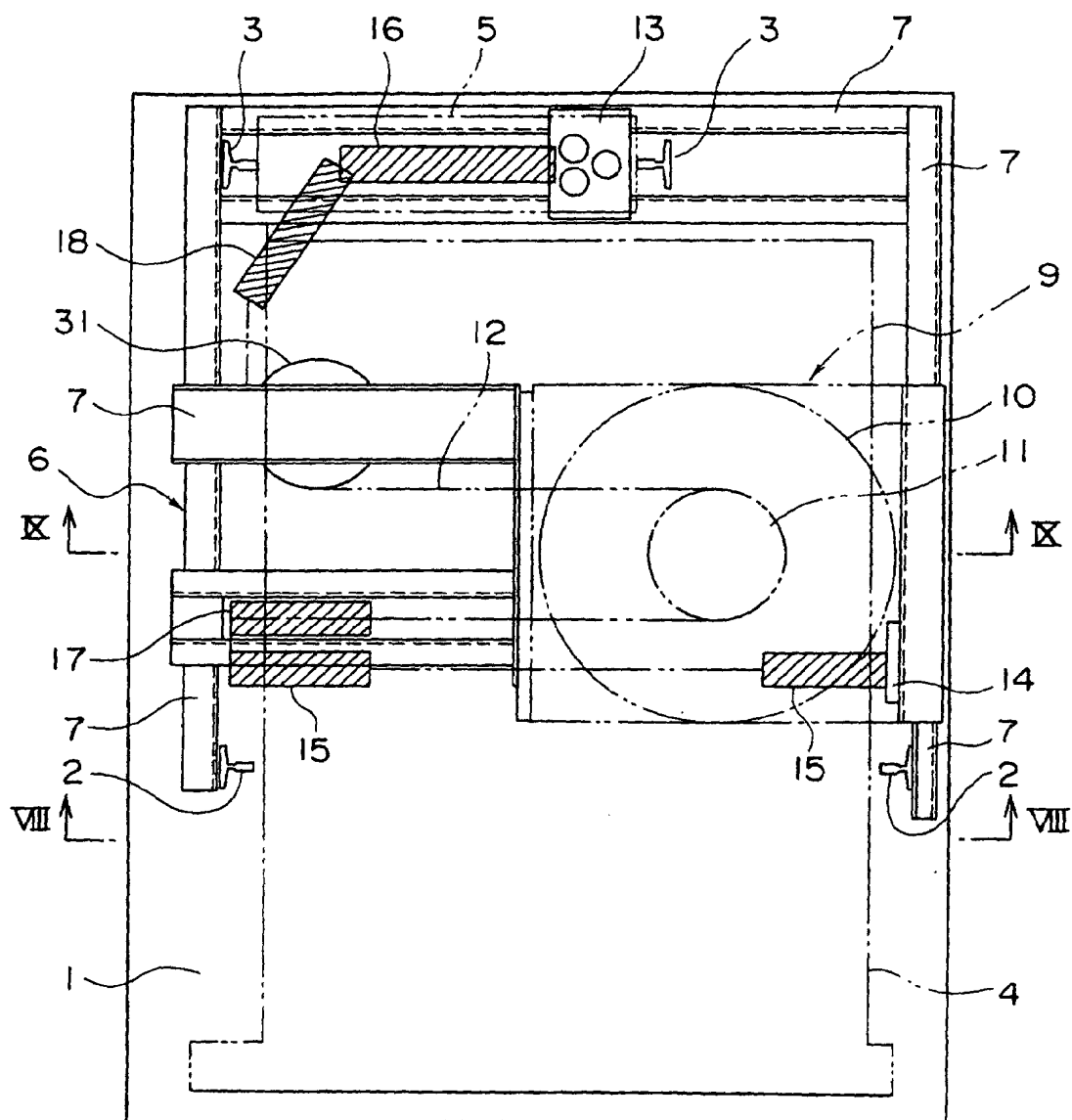


FIG. 8

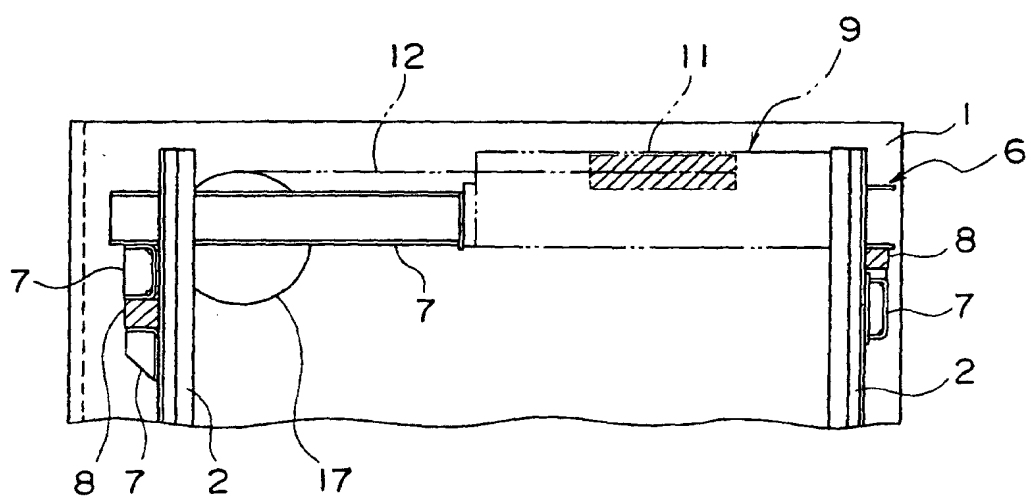
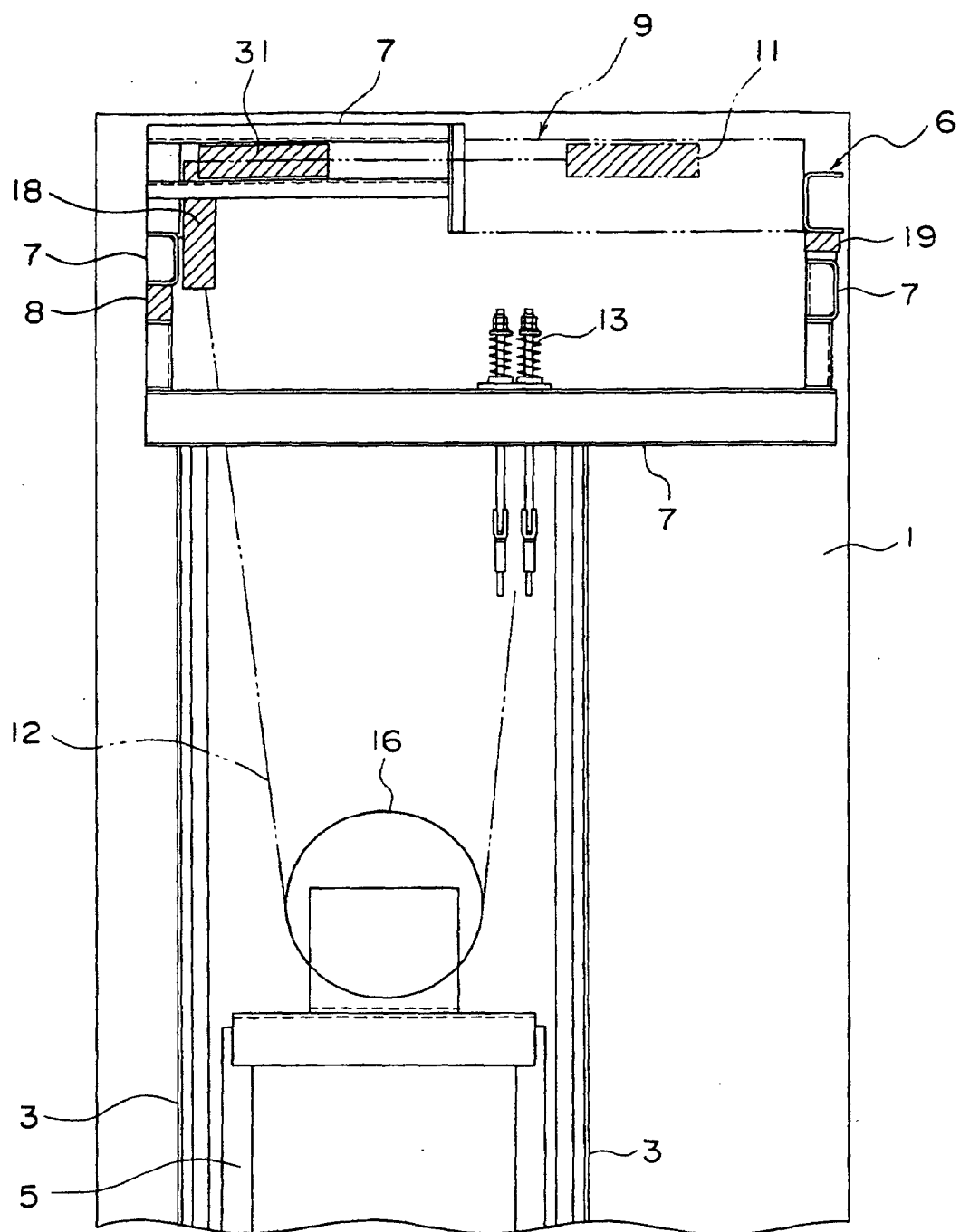


FIG. 9



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/05822

A. CLASSIFICATION OF SUBJECT MATTER  
Int.Cl.<sup>7</sup> B66B 7/00, 11/08

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
Int.Cl.<sup>7</sup> B66B 7/00-11/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2000  
Jitsuyo Shinan Toroku Koho 1996-2000 Toroku Jitsuyo Shinan Koho 1994-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 10-139321 A (Inventio AG), 26 May, 1998 (26.05.98) & US 6006865 A & CA 2220582 A & EP 0841283 A1	1-8, 11 9-10
Y A	JP 8-208152 A (Kone OY), 13 August, 1996 (13.08.96) & EP 0710618 A2 & DE 69517915 D & AT 194588 T & FI 96198 B	1-8, 11 9-10
Y A	JP 2000-211851 A (Hitachi Building Systems Co., Ltd.), 02 August, 2000 (02.08.00) (Family: none)	7 10

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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Date of the actual completion of the international search  
11 September, 2000 (11.09.00)

Date of mailing of the international search report  
19 September, 2000 (19.09.00)

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